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ABSTRACT

Reported are two experiments investigating children's comprehension and production of the causal connectives "because" and "so" in empirical and intentional modes of explanation. In the empirical mode, "because" introduces a description of a cause, whereas "so" introduces a description of an effect. In the intentional mode, "because" is used to introduce an agent's reason for acting, and "so" is used to introduce a description of an obtained result. Participating in experiment 1 were 16 subjects in each of three age groups: 5-year-olds, 8-year-olds, and 10-year-olds. Participants in experiment 2 were 24 children 5 years of age and 24 children 8 years of age. Comparison groups of adults also took part in both experiments. Subjects responded to sentence completion tasks and tasks eliciting answers to why questions. Findings indicated that by the age of 5 years children have a good grasp of how "because" is used in the empirical and intentional modes, and also of how "so" is used in the intentional mode. Concluding discussion focuses on six possible explanations for conflict in previous findings concerning the ages at which children correctly produce causal connectives and succeed on comprehension experiments involving causal connectives. Each explanation is evaluated by assessing whether it could account for the discrepancy between the present findings and findings of previous studies of children's comprehension. (RH)

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Children's comprehension and production of causal connectives

Morag L. Donaldson

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Abstract

A distinction is drawn among three modes of explanation: the empirical mode (explanations of events), the intentional mode (explanations of actions) and the deductive mode (explanations of conclusions). This paper reports two experiments which investigated children's comprehension and production of the causal connectives because and so in empirical and intentional mode explanations. In both experiments, even the youngest subjects (five-year-olds) performed at a high level. This finding is consistent with previous findings from observational studies of production but conflicts with previous findings from comprehension experiments which have suggested that children do not understand causal connectives until seven years. Possible explanations of the discrepancies in results between the different types of studies are discussed. It is argued that five-year-olds are able to comprehend and produce causal connectives correctly, but that they have difficulty with tasks which require them to construct a new mental representation solely on the basis of an isolated causal sentence.

Modes of explanation

Imagine the following scenario. A naughty child, John, decides that he wants to break a window, so he throws a ball at the window. The window breaks, and there is broken glass lying on the ground below the window. The following questions might be asked about this incident:

(1) Why did the window break?

(2) Why did John throw the ball?

(3) How do you know the window broke?

The distinction among these three types of question corresponds to the distinction which I have drawn among three modes of explanation: the empirical, intentional and deductive modes (Donaldson, 1986). These three modes of explanation provide the framework for my research.

The question Why did the window break? is likely to elicit an explanation in the empirical mode, such as:

(4) The window broke because John threw a ball at it.

In giving an empirical mode explanation, the speaker views the phenomenon being explained as an event (e.g. the window broke) which can be explained in terms of a temporally prior event (e.g. John threw a ball at the window). Thus, an empirical explanation provides an answer to a why question, where why is interpreted as "what happened to cause?".

Explanations in the intentional mode also provide answers to why questions, but they involve interpreting why as "for what purpose?",

as in:

(5) Why did John throw the ball?

(6) John threw the ball because he wanted to break the window.

Here, the speaker is viewing the phenomenon as an action (John threw the ball), and is explaining it in terms of the agent's intention to achieve a particular result (he wanted to break the window).

Deductive mode explantions are likely to be given in response to how do you know questions, such as:

(7) How do you know the window broke?

(8) I know the window broke because there is glass on the ground.

In this case, a conclusion (that the window broke) is explained in terms of observable evidence (there is glass on the ground). More generally, deductive explanations can be defined as explanations in which the speaker views the phenomenon as a "mental act" (i.e., an idea, judgement or conclusion) and explains it in terms of another mental act, or a rule, or some evidence.

My research has investigated children's ability to handle explanations in each of the three modes. It has focussed particularly on the development of a set of linguistic abilities which are central to the ability to explain: comprehension and production of the causal connectives, because and so; and comprehension of why and how do you know questions.

This paper reports two studies which investigated children's ability to handle explanations in the empirical and intentional modes. (Further details of these studies and of studies based on the

deductive mode are given in Donaldson, 1986).

Research on children's understanding of causal connectives

Research into children's understanding of causal connectives has yielded discrepant results. On the one hand, evidence from Piaget's work (1926, 1928) and from more recent comprehension experiments (e.g. Emerson, 1979; Bebout, Segalowitz and White, 1980) has suggested that children younger than about seven years lack an adequate understanding of *because*. On the other hand, evidence from observational studies of language production (e.g. Hood, 1977; McCabe and Peterson, 1985) indicates that children are able to use *because* correctly from as early as two-and-a-half years.

This discrepancy in results may be related to methodological differences between the two sets of studies. However, there are many differences between observational studies of production and comprehension experiments, so it is difficult to determine which particular differences are responsible for the discrepant results.

The two studies reported in this paper offer a partial solution to this problem in that they used methods which are a compromise between the two types of method used in most previous research. The present studies investigated both comprehension and production of causal connectives in an experimental setting. It will be argued that the experimental setting used in these studies is less artificial than in most previous comprehension experiments involving causal connectives.

Experiment 1: the empirical mode

The aim of this experiment was to assess children's understanding

of because and so in the empirical mode, that is in explanations of events. In the empirical mode, because introduces a description of a cause, whereas so introduces a description of an effect. The semantic contrast between because and so is illustrated by the following sentences:

EFFECT CAUSE
(9) The cup broke because it fell.

CAUSE EFFECT
(10) The cup fell so it broke.

There were 16 subjects in each of three age groups: five-year-olds, eight-year-olds and ten-year-olds. (A comparison group of adults also took part in the experiment.)

All the subjects received 16 items, consisting of 8 because items and 8 so items. For each item, the child was shown a video-tape of a causal sequence being acted out by two puppets (Coco and Daisy). The causal sequences were made up of three events, with the first event (A) being the cause of the second event (B) which in turn was the cause of the final event (C), for example:

Coco pushes the cup (A)
↓
the cup falls (B)
↓
the cup breaks (C)

After showing the video, the experimenter presented the child with

two static picture cards depicting events A and C, and read out an incomplete sentence of the form B because... or B so..., such as:

(11) The cup falls because...

(12) The cup falls so...

The child's task was to complete the sentence and choose the corresponding picture. The correct response was to choose and describe the picture of event A for because items and of event C for so items.

The results are presented in Tables 1 and 2. (The adult subjects performed at ceiling level.) For present purposes, the main points to note concern the five-year-olds. Overall, 76% of their responses were correct, which is better than would have been expected on the basis of most previous comprehension experiments. The five-year-olds' performance was particularly impressive for because items, with all except one of the subjects responding consistently correctly to these items. Performance on the so items was significantly poorer ($p<0.05$). (See Donaldson, 1986, for a discussion of possible reasons for this finding.)

These results indicate that by the age of five years children understand how because is used in empirical mode explanations: They know that because is used to introduce the cause of an event.

Experiment 2: the intentional mode

This experiment explored children's ability to handle explanations of actions in terms of intentions - an ability which has received very little previous study by child language researchers.

The subjects were 24 five-year-olds and 24 eight-year-olds.

(Again, adult data were also obtained.) The children received two tasks, a questions task and a sentence completion task. For each item in both tasks, the experimenter showed the child two pictures and told a story about them. The top picture always depicted an action (e.g., John winding up a toy car), and the lower picture always depicted a result of the action (e.g., the car going). The agent's intention to achieve the result was neither depicted nor referred to in the story. For each of the 12 items in the questions task, the child had to answer a why question about the action depicted in the top picture, for example:

(13) Why did John wind up the car?

In the sentence completion task, the child was asked to complete a sentence fragment which described the action and ended in either because or so, such as:

(14) John wound up the car because (so)...

Each subject received 8 because items and 8 so items.

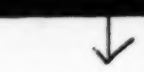
Let us consider the cognitive and linguistic demands which the intentional mode tasks placed on the child. For each item, the child was being required to reason about a sequence consisting of a reason, an action and a result, such as:

John wants the car to go (REASON = INTENTION)

↓

John winds up the car (ACTION)

↓



the car goes (RESULT)

Since the reason (or intention) was not explicitly mentioned, the child had to infer the reason on the basis of the result. At the same time, the child had to maintain a distinction between the reason and the result. In order to show that she had maintained this distinction, the child had to use a linguistic construction appropriate to the intentional mode, such as:

(15) John wound up the car to make it go

(16) John wound up the car because he wanted it to go

(17) John wound up the car so (that) it would go.

If the children were confused about the distinction between the intention and the result or about the way causal connectives are used in the intentional mode, then they would be liable to produce errors (or inversions) such as:

(18) *John wound up the car because it went

(19) *John wound up the car so he wanted it to go

(20) *John wound up the car because it would go.

The results presented in Table 3 show that the children in both age groups made very few errors and that a large proportion of their responses were well-formed sentences in the intentional mode. Thus, by the age of five years, children know how causal connectives are used in giving explanations of actions in terms of intentions.

Discussion

In previous research on children's knowledge of the causal connectives' meaning, there is a huge discrepancy between the results of comprehension experiments and the results of observational studies of production. There is no problem in thinking of methodological differences between the two sets of studies which might account for the discrepant results. Rather, the problem is that the methodological differences are so numerous that it is almost impossible to determine which of them are actually responsible for the difference in results.

From a methodological point of view, the studies reported in this paper occupy a middle ground relative to the two main types of previous study. My studies employed experimental rather than observational methodology, but they investigated production as well as comprehension. Indeed, each of my tasks required the child to make use of both comprehension and production abilities. The sentence completion tasks (used in both experiments) required the child to:

(a) comprehend the first clause and the causal connective
and (b) produce the second clause of the causal sentence.
The questions task (used in Experiment 2) required the child to:

(a) comprehend the question
and (b) produce the causal connective and the associated clause.
Thus, like everyday dialogues, my tasks involved frequent switching between the roles of speaker and listener. (Elsewhere - Donaldson, 1986 - I have reported a questions task which included empirical mode items. The results are broadly comparable to those obtained for the sentence completion task in Experiment 1.)

It is interesting to compare the results obtained from this "mixed" method with those of previous production and comprehension

studies. The results of my two studies indicate that by the age of five years children have a good grasp of how because is used in the empirical and intentional modes, and also of how so is used in the intentional mode. These results are compatible with the results of observational studies of production which show that children as young as two-and-a-half years are able to use causal connectives correctly in their speech. However, it is not possible to make a full comparison between the two sets of results, since my sample did not include children younger than five years.

A more extensive comparison can be made between my findings and those of previous comprehension experiments. In most previous comprehension experiments, children have not demonstrated an understanding of causal connectives until the age of about seven years. This conflicts with the relatively high level of performance shown by five-year-olds in my studies.

The methodological differences between my studies and previous comprehension experiments are less than those between previous comprehension experiments and previous observational studies of production; but despite this, there is still a discrepancy in results between the earlier comprehension experiments and my studies. This discrepancy in results should be easier to explain than that between the two types of previous study, since the number of methodological differences has been reduced. Furthermore, a consideration of possible reasons for the discrepancy between my results and those of previous comprehension experiments may well shed some light on the most likely explantion for the discrepancy in results between the two types of previous study.

I am going to outline some of the possible explanations for the conflict in previous results - i.e. children as young as

two-and-a-half years produce causal connectives correctly, whereas children do not succeed on comprehension experiments involving causal connectives until seven years. I shall evaluate each explanation by considering whether it could account for the discrepancy between my results and those of previous comprehension experiments.

Explanation 1: Children younger than seven years are unable to cope with causal connectives in experimental tasks, but they are able to cope with causal connectives in natural situations.

This explanation could not account for my findings which demonstrate that five-year-olds can produce and comprehend causal connectives in the context of an experimental task.

Explanation 2: Children younger than seven years are unable to comprehend causal connectives, but are able to produce causal connectives.

As well as being rather counter-intuitive, this explanation could not account for my finding that five-year-olds were able to both comprehend and produce causal connectives.

Explanation 3: Children younger than seven years succeed in producing causal connectives correctly only through imitating causal sentences which they hear from adults.

Since the sentences used in my tasks were almost certainly novel to the children, the high level of performance cannot be attributed to imitation.

Explanation 4: Children younger than seven years are able to cope with causal connectives only when they occur in sentences which refer

to intentions.

Explanation 4 is a specific version of a more general type of explanation which postulates that discrepancies in results between comprehension experiments and production studies are due to contextual limitations in children's semantic knowledge. In observational studies of production, children have a considerable degree of control over the content of their sentences: They can choose what they talk about. On the other hand, in comprehension experiments, the content of the sentences is determined by the experimenter. Thus, if young children's knowledge of a word's meaning is restricted to particular linguistic contexts, then this is more likely to lead to errors in comprehension experiments than in spontaneous speech.

Hood (1977) noted that many of the correct uses of causal connectives in her observational study of production involved references to intentions. She proposed that young children's poor performance in comprehension experiments might be attributable to their knowledge of the causal connectives' meaning being restricted to contexts involving intentions. However, my findings can be used to argue against explanation 4, since five-year-olds performed well on the empirical mode task which did not involve expressions of intentions. Furthermore, in another of my studies (Donaldson, 1986), even three-year-olds used causal connectives correctly in sentences expressing relations of physical causality.

Explanation 5: Children younger than seven years are able to cope with causal connectives only when they occur in sentences which express familiar content.

Like explanation 4, this is a specific version of the "contextual

restriction" explanation. In observational studies of production, children are typically talking about familiar phenomena and about events which they have personally experienced. In contrast, the sentences which are presented in comprehension experiments often describe phenomena which are more remote from the child's personal experiences. Consequently, if young children's knowledge of a word's meaning is restricted to uses involving familiar content, they are likely to perform better in observational studies of production than in comprehension experiments.

A version of this argument has been put forward by French and Nelson (1985) who propose that children's understanding of relational terms is initially restricted to contexts in which personally experienced events are being described. They argue that this is because young children can comprehend and produce sentences which describe an event for which they have already formed a mental representation; but when young children hear a sentence, they cannot construct a new mental representation of an unfamiliar event purely on the basis of the sentence. As French and Nelson point out, many comprehension experiments in fact require children to construct a new mental representation on the basis of linguistic input alone.

In my studies, it is unlikely that the children would have personally experienced the particular sequences of actions and events which formed the basis for the items. However, my tasks did not require the children to rely on the causal sentences in order to construct mental representations of the relevant actions and events. In Experiment 1, the children were shown video sequences and pictures which provided an opportunity to build up an appropriate mental representation before they had to complete the sentence fragment. Similarly, in Experiment 2, the children had the opportunity to use

the pictures and stories as a basis for constructing mental representations relevant to the sentence completion and questions tasks. Thus, my results indicate that if familiarity of content is important, then the level of familiarity required by five-year-olds is so low that it can be built up very rapidly within the constraints of an experimental task. Five-year-olds can use and understand causal connectives correctly without having personally experienced the actual events and actions which are being described.

Explanation 6: Children younger than seven years have difficulty in constructing a new mental representation purely on the basis of a single causal sentence.

It is this explanation which provides the most satisfactory account of the discrepancy between my results and those of previous comprehension experiments. As discussed above, my tasks did not require children to build up a mental representation purely on the basis of an isolated causal sentence. Instead, videos, pictures and stories were used to create a supportive context for the children's use and understanding of causal connectives. It is important to note that although my tasks provided a supportive context, children could not have succeeded on the tasks unless they understood the causal connectives. Of course, previous comprehension experiments have also employed pictures, toys etc. However, these have typically been used as the means by which the subjects make their response rather than as a supportive context - for example, the subjects may have to choose a picture to match a sentence (as in Emerson, 1979). Indeed, contextual cues are usually deliberately excluded from comprehension experiments.

Explanations 5 and 6 are, of course, closely related. If the

phenomena being described are familiar, then there is no need to construct a completely new mental representation. However, even if the content is unfamiliar, the need to create a new mental representation solely on the basis of linguistic input can be avoided by providing an appropriate non-linguistic context.

A comparison of my findings with those of previous comprehension experiments suggests that five-year-olds are able to comprehend and produce causal connectives even if they have not personally experienced the events being described, so long as they are not required to create a mental representation purely on the basis of an isolated causal sentence. Thus, the evidence is consistent with French and Nelson's general argument that young children are not good at constructing new mental representations purely on the basis of linguistic input. The evidence is also compatible with Margaret Donaldson's (1978) argument that young children experience difficulty with "disembedded" tasks.

In future research, it would be interesting to investigate how children younger than five years perform on tasks like those reported in this paper. A possible developmental sequence would be that children's ability to comprehend and produce causal connectives is initially restricted to descriptions of personally experienced events; then it develops to include descriptions of unfamiliar phenomena which are produced with a supportive non-verbal context; and finally children develop the ability to comprehend causal connectives in isolated causal sentences.

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TABLE 1: Mean number of correct responses

	Because (Maximum = 8)	So (Maximum = 8)	Total (Maximum =16)
5 years	6.69	5.44	12.12
8 years	7.75	5.38	13.12
10 years	7.75	7.06	14.81

TABLE 2: Number of subjects who "passed" on each type of item and overall.

	Because	So	Overall
5 years (N = 16)	15	7	7
8 years (N = 16)	16	8	14
10 years (N = 16)	16	14	15

Note: To pass subjects had to have at least 7 (out of 8) correct on "because" or "so" items or at least 12 (out of 16) correct overall. (Binomial distribution, $p<0.05$).

TABLE 3: Mean number of well-formed intentional responses and mean number of inversions. (Maximum per cell = 12).

	Intentional (correct)	Inversions (errors)
Questions		
5 years	9.71	0.75
8 years	9.83	0.21
Completion		
5 years	7.85	1.40
8 years	9.95	0.65